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CASE STUDY ON LEAN MANUFACTURING FOR MINIMIZATION OF DEFECCTS IN THE FABRICATION PROCESS OF SHIPBUILDING

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Note: This paper has been accepted for publication from the submissions made at the 2nd National Conference on *Intelligent Manufacturing & Sustainable Energy Systems (IMSES 2016) - Pakistan*

ABSTRACT:

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There are various common problems in the traditional fabrication process of certain components of ship. These problems not only result in poor performance but also hamper the process of attaining quality assurance standards of the shipbuilding industry. However, application of more efficient processes can overcome such problems in the shipbuilding and fabrication processes. In this regard, lean manufacturing approach based defect analysis can be a feasible option to resolve such problems of poor quality. In this work, lean manufacturing technique based defect analysis approach is applied at certain stages of fabrication process of shipbuilding for bringing better quality and results. The results reveal that a considerable improvement in the quality of fabrication process of ship can be achieved in terms of reduction in the number of defects, which is not possible under traditional manufacturing process. The paper accordingly highlights an opportunity and methodology to improve the current manufacturing and shipbuilding processes in the light of productivity improvement initiatives implemented in other industries (under the umbrella of lean).

1. INTRODUCTION:

The shipbuilding industry generates millions of dollars for the support and development of country and hence enjoys a prominent position in country's economy. Without the value-added process of company, the life cycle of product does not carry any wealth. That is why the shipbuilding industries are also implementing lean manufacturing techniques in their manufacturing systems to avoid the delay in completion product and to reduce the wastage of material. The fabrication is the main value added process of the manufacturing of ship blocks and the inspection of the surveyor is key component to ensure integral structural members of ship to complete as per given specification without defect. However, it is not possible that every ship did not contain any defect in the fabrication Process. The first world countries have the robust facilities in their shipbuilding yards for lean

production and repair facilities on account of having the leading-edge shipyards and contribute considerable revenues to their economy by Guido Perla at al [1]. Further the shipbuilding industry not only earns heavy revenue and profit but also enable countries to enhance their defence capability for protection of their geographic location in sea by manufacturing the warships and submarines as Tsuji Zhangjiagang in China, Flensburger Schiffbau Gesellschaft Germany, two shipyard of Spain Gondan Asturias and H.J. Barreras Vigo and one of shipyard from Turkey Besiktas Yalova.

The geographic location of Shipyards has the great impact on sale and purchase of products according to strategic clients purchasing needs and power. The Europe is shown in the left side of according to Google map and Asia reflected on the right side of picture, therefore, both of regions have a separate market of business but the China in this region is current world leader of the shipbuilding industry as shown in (Figure 1).

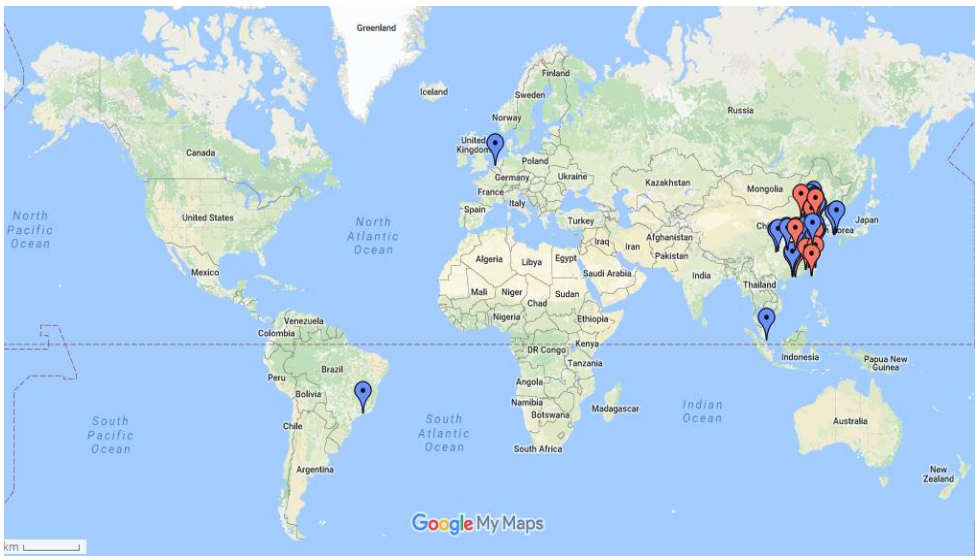


Figure 1. Strategically Contribution of Shipyards

Historically, most of countries has been played a prominent role such as Europe, Asia, South Korea and Japan since 19th to 20th century. The product development cycle has been improved by this competition in between these shipyard and most of lean shipyards belongs to Europe, Japan, and China in reduction of defects in the fabrication processes. The major junk of shipyards are existing with Asia 34% and Europe 31% and rest with other regions as shown in (Figure 2).

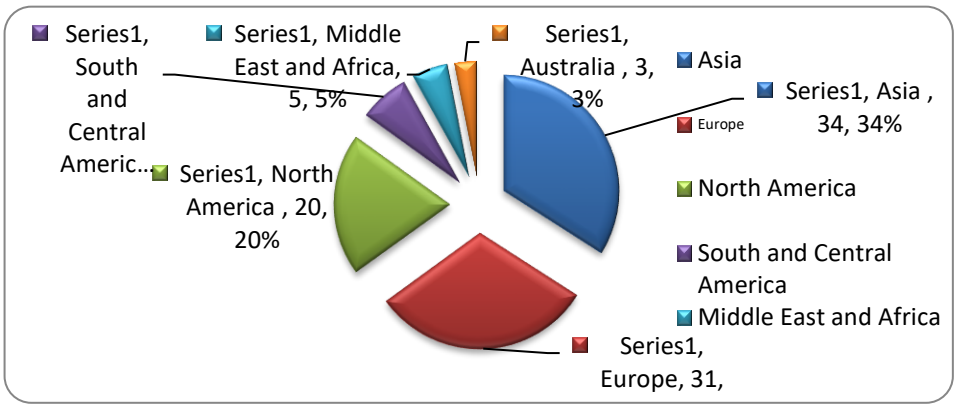


Figure 2. Contribution of Shipyards according to regions

As every shipyard want to be the cost and quality assurance and control effective to ensure the product development cycle during product realization. So in that regards shipyards are focusing for professional trainings, standardization, and sustainability in the product cycle. The inspection manager has to face and manage inspection to control the defects in the fabrication process but that was not possible as research and development changes the profile of ships varying in different sizes and functions. The considerable asset taken into account in atomization in the product development cycle to minimize the defects and time delays. This is how the traditional shipyard are closing day by day due to latest development in the production facilities. The model of lean manufacturing as resembling to Toyota motors was implemented is the one of the source for the sustainability of shipyard in manufacturing of ships due to provision of flexibility in modification because of R&D in design, in jig and fixture over a production cycle according to clients.

Most of traditional shipyards are closing due to their financial crises and competitiveness as compared to advanced lean shipyards. Generally, manufacturing businesses have to alter from a traditional mass manufacturing practices to a healthier and well-organized and flexible production technique such as lean production. In order to decrease costs and to enhance quality certain innovative techniques are introduced in manufacturing processes. Lean manufacturing is one of such useful technique and it is implemented with the objective to reduce time from source to destination of a product by reducing sources of unwanted processes in the production stream by Liker, J.K [2].

There are certain stages in the fabrication process where the product process is hindered in-between value-added activities and non-value added activities. The rework due to defects and repair in welding of block fabrication, machinery installation, erection of blocks, deck and superstructure as well as electrical installation causes to increase the size of non-value added activities which enhance the cost of production. Shipyards can further enhance their competitiveness and efficiency by organizing the most operative professional systems and controlling techniques using lean manufacturing processes.

Lean manufacturing system enable the manufacturer to consume less resource as in input to produce a higher performance which in principle building the customer satisfaction and improvement greater market stake than those of its competitors by Katayama and Bennett [3].

Hypothetically, lean production is the industrialized system without waste, although waste is anything which is unused leftover or overused over processing of resources within the product lead time in the production by Shahram [4].

Similarly, lean production is the organized elimination of waste by all members of the industry from the working areas of the value stream of product cycle, whereby the value stream activities are contributing to the transformation of a product from raw material to finished product by Worley and Doolen [5].

Moreover, lean production is the calculated realization to manufacturing having an objective to eliminate or reduce the waste while emphasizing the need of continuous improvement by Papadopoulou and Ozbayrak [6].

Lean production is the intangible framework which has established principles and techniques such as multi-functional teams, elimination of zero-value activities, continuous improvement and supplier

integration to gain production efficiency and effectiveness and delivering a raw material on the basis of just-in-time by Sanchez and Perez [7].

Likewise, lean production has the multi-dimensional approach that include several management tools as just-in-time, quality management system, workforce, cellular manufacturing, and supplier management which is known to be integrated system by Shah and Ward [8] but all industries are now focusing on the importance of technology and innovation in lean production. Manufacturing corporations do not retain with lean production that would lose out to competitors. Manufacturing corporations contest only on new technological, creative, and innovative and hallmark quality of products to achieve high profit of the market by Agus and Hajinoor [9]. Shipbuilding industry can generate massive revenue by implementing the best lean practices of ship building to reduce defect and rework.

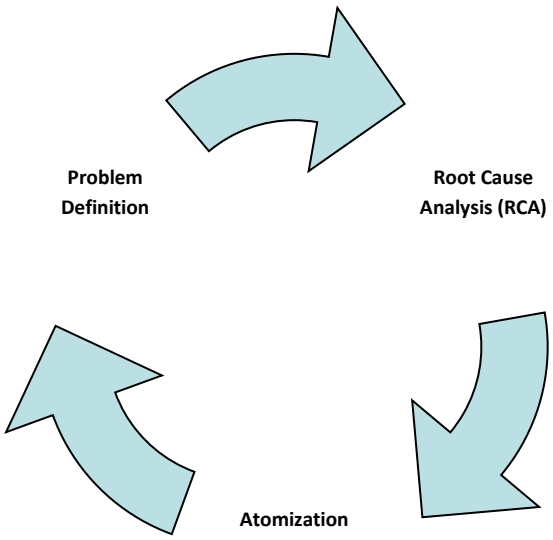


Figure 3 Defect Based Production Cycle

2. RESEARCH AIMS:

This study is projected on Defects based production cycle (DBPC) to deliver assistance to both academicians and professional engineers and practitioners to reduce the delays in work orders. The study will explore fabrication defects and their reduction in production of ships by implementing of lean manufacturing techniques. In the manufacturing sector where most of employees has a knowledge of engineering but they did not care about the defects, repair, rework, and their associated causes. This study embraces the scholars, policy makers and producers how to increase the performance and reduce the wastages from the production processes to improve the whole product cycle.

3. RESEARCH APPROACH:

This research presents the methodology that is based on new lean techniques in which it covers the listed areas as the Model designing, target population, data collection and data analysis.

The designed model is based on Defects based production cycle (DBPC) in which lean manufacturing based defect analysis approach is applied at four processes such as hull fabrication and erection, birth

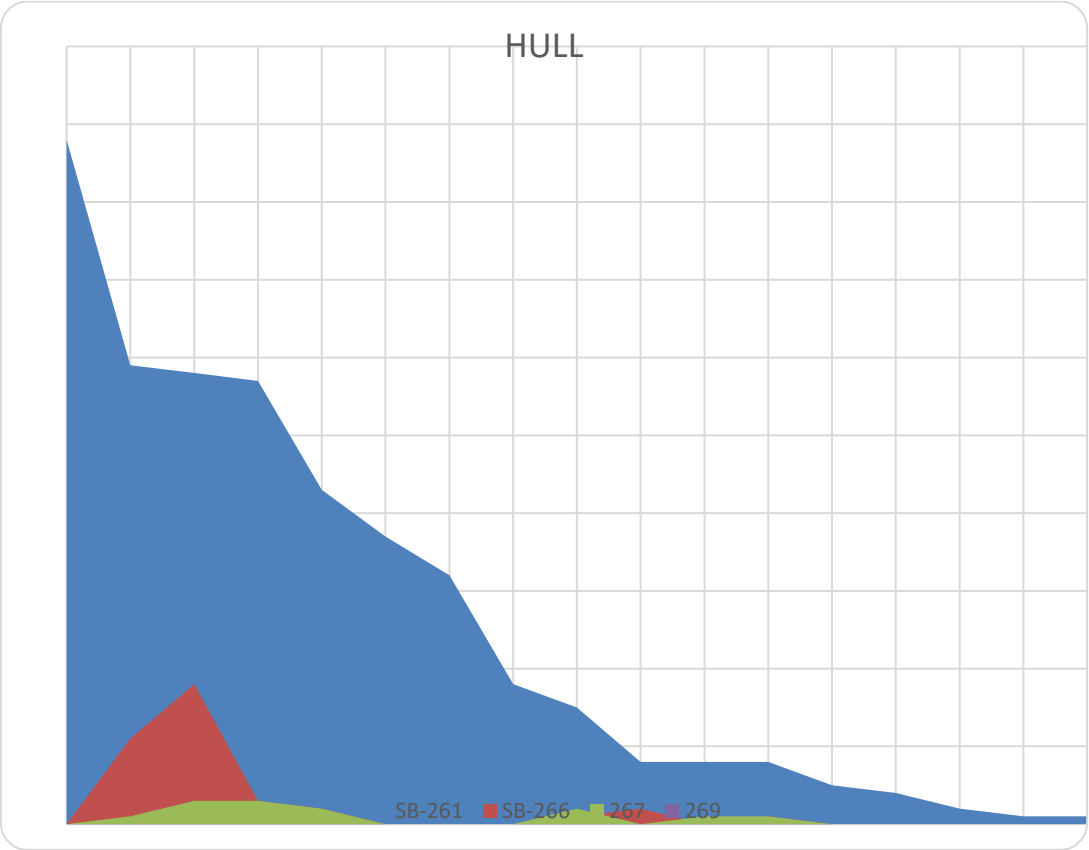
and machinery outfit, paint and electric power generation of shipbuilding/fabrication processes and variance in the performance is evaluated with the objective to enhance quality and to reduce the total costs. Defect base production cycle for implementing is the new tool to improve the manufacturing processes, as is illustrated in Fig.3.

This cycle is defined as when problems arises at the production area such as defects, repair or rework all are associated with the 6Ms which include Man, Material, Machine, Measuring, Method and mobility of workers. In order to find the root cause of problem the defect is processed and scrutinizes to obtain the outcome of analysis. As the outcome is achieved by the RCA that requires engineering mistake proof atomization system shall be implemented to avoid the reoccurrence of the similar defect.

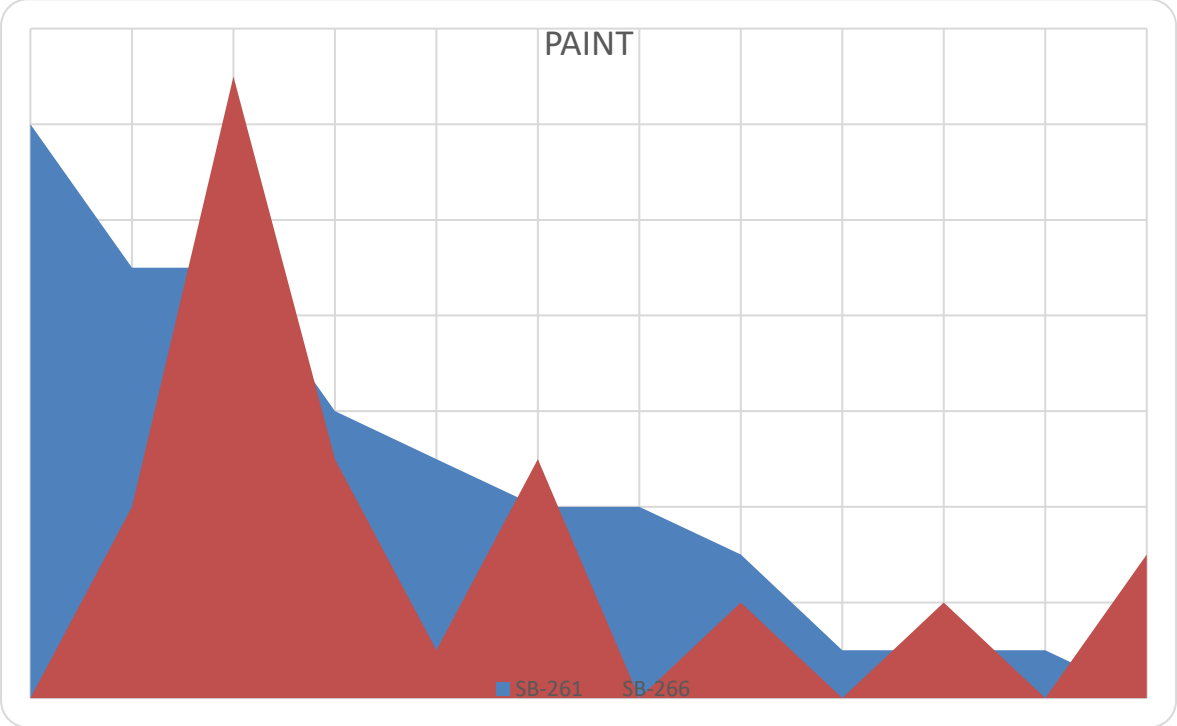
It is difficult to work on the defects where you have very limited ships are in the process of manufacturing and fabrication. In order to validate the DBPC model, the population data of two same types' ships were taken into account. A ship when it is completed all defects were analyzed and then automated system was introduced based on 6 Ms to encounter similar defects to reduce the repair and rework in order to reduce the delays.

4. Results

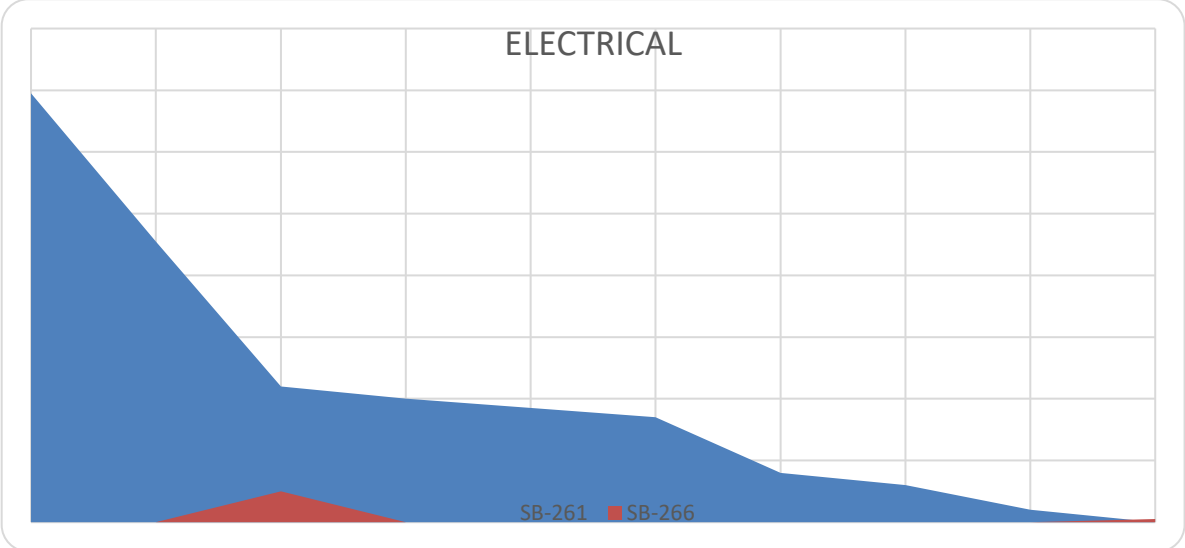
The application of this technique caters to speed up the processes and minimize the repair rework in hull, paint and electrical during construction of ship. The results of hull and machinery reveal that there is considerable reduction of defects in hull and outfit the defects includes welding defects, electrical connectivity defects, machinery alignment defects.



This chart reveals that the amount of defect in hull section are reduced and also eliminated from the production development cycles. The defects include over grinding, excessive welding, undercut pin holes, cavity, incorrect assembly, misalignment, incomplete welding as per joint design, incomplete work on inspection, self-check, not as per drawing, uneven fabrication, corner edge welds, non-systematic processes, deformation, cleaning, reworks, wrong equipment, penetration and marking all defect are reduced or eliminated after implementing Defect-based production cycle (DBPC).



The results of paint based defects like cleaning, sagging, derusting, pinholes, low dry film thickness, incorrect paint code, missing paint, cavities, rework, expired paint related problems and peel off problems are minimized after implementing the DBPC.



The results of electrical process expose that problems of in secured loose cabling, incorrect cable laying, missing instruments, resistance and earthing, self-check, incorrect panel connections, not as per specifications, insulations, fuse indication of light, defects are reduced and eliminated.

5. CONCLUSIONS:

Defect Base Production Cycle with 6Ms is the new Lean manufacturing tool which will enable engineers and manufacturer to minimize of non-value added activities. This cycle will reduces the defects, over-processing, manual inspections, mobility of products, manual operations, repairs, saves production man-hours, material costs up to 15% of overall costs of production and ensures effective utilization of resources. Future work of this study shall be carried out on maintenance of machinery which can validated to check the possible outcomes on basis of implementing Defect base production cycle (DBPC). This model has worth for engineers, manufacturer, scholars and industrialist to enhance their productivity in shipbuilding and the manufacturing sector.

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